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Mennemann et al.

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[54] **CDO-THO_2-FREE, HIGHLY REFRACTIVE OPTICAL GLASS**

[75] Inventors: **Karl Mennemann**, Taunusstein; **Volkmar Geiler**, Mainz-Finthen, both of Fed. Rep. of Germany

[73] Assignee: **501 Schott Glaswerke**, Mainz, Fed. Rep. of Germany

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[3] **C03C 3/08**; C03C 3/10

[52] **U.S. Cl.** **501/75**; 501/76; 501/78; 501/901

[58] **Field of Search** 501/75, 76, 78, 901

[56] **References Cited**

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Primary Examiner—Mark Bell

Attorney, Agent, or Firm—Haight & Associates

[57] **ABSTRACT**

CdO- and ThO-free, highly refractive optical glass having a refractive index of 1.85–2.05 and an Abbe index of 25–43, characterized by the following composition (in percent by weight):

SiO_2	5–15
B_2O_3	2.5–8
$SiO_2 + B_2O_3$	7–23
SiO_2/B_2O_3	1.3–2.1
La_2O_3	43–56
Gd_2O_3	0–14
$La_2O_3 + Gd_2O_3$	43–60
ZrO_2	3–10
Nb_2O_5	0–15
Ta_2O_5	0–20
$Nb_2O_5 + Ta_2O_5$,	11–22

5 Claims, No Drawings

CDO-THO$_2$-FREE, HIGHLY REFRACTIVE OPTICAL GLASS

TECHNICAL FIELD OF THE INVENTION

The present invention relates to highly and maximally refractive optical glasses with a high Abbe index and to the manufacture of optical glasses with previously unattained refractive indexes of up to 2.05 and Abbe indexes of >25.

BACKGROUND OF THE INVENTION

Japanese published patent application No. 79/133,506 describes glasses having refractive indeces of 1.90–1.95 and similar Abbe values as described in the present invention; however, refractive values of only up to 1.95 can be achieved and these values only if a considerable amount of GeO_2 is employed, which is very expensive.

Glasses having refractive values of up to 1.95 and similar Abbe indexes are also described in Japanese published patent application 79/90,218; however, these familiar glasses contain either expensive GeO_2 or are not sufficiently stable towards devitrification.

DISCLOSURE OF THE INVENTION

The present invention relates to highly and maximally refractive optical glasses with a high Abbe index and to the manufacture of optical glasses with refractive indexes of up to 2.05 and Abbe indexes of greater than 25.

One very important characteristic of the present invention is the surprisingly high ratio of SiO_2/B_2O_3, which lies between 1.3 and 2.1 in accordance with the invention. Most previously known glasses in this elevated position in the nd-, vd-diagram have required formulas in which the B_2O_3 component was greater than the SiO_2 component. For example, the maximum SiO_2/B_2O_3 ratio in glasses according to DOS 26/53,581 is equal to 1. In glasses according to DAS No. 1,926,959 with nd=1.9 and vd=40, the SiO_2/B_2O_3 ratio is approximately 0.75; moreover, these glasses contain expensive GeO_2. The same holds true for glasses according to DOS 20/57,706.

Some other highly refractive optical glasses having an SiO_2/B_2O_3-ratio of $\geqq 1$ are described in DAS 1,061,976. All examples named therein with refractive indexes of >1.85 have La_2O_3 components of about 63 percent by weight. Such high concentrations of La_2O_3 components destabilize the glasses; additionally, these glasses must contain Al_2O_3 or Y_2O_3.

The optimum SiO_2/B_2O_3 ratio according to the invention lies between 1.6–1.9. To achieve the required high refractive indexes of $\geqq 1.86$, 43–56 percent by weight of La_2O_3 are required and, optionally, 0–14 percent by weight of Gd_2O_3, with the sum of these two components amounting to 43–60 percent by weight.

The amount of ZrO_2 is between 3–10 percent by weight. It is mandatory to have 11–22 percent by weight of the pentavalent substitute glass producers Ta_2O_5 and Nb_2O_5, whereby the component of Nb_2O_5 may be between 0–15 percent by weight and that of Ta_2O_5 between 0–20 percent by weight. Only with these high amounts of Nb_2O_5 and/or Ta_2O_5 can glasses of the required optical position be molten which are sufficiently stable to devitrification; additionally, these components increase the refractive index considerably. Additionally, PbO, (0–13 percent by weight), TiO_2 (0–13 percent by weight), WO_3 (0–23 percent by weight) and ZnO (0–3 percent by weight) can be added.

BEST MODE FOR CARRYING OUT THE INVENTION

Glasses in accordance with the present invention are produced in the following manner: The starting materials (the appropriate oxides, nitrates, and carbonates) are weighed in accordance with the formula; a small portion of refining agent, such as As_2O_3, is added in small amounts and everything is mixed well. This mixture is melted in a Pt-crucible at 1450–1550 degrees C., is clarified and homogenized well by means of an agitator. The mixture is then stirred until the casting temperature of about 1400 degrees C. is reached, and is then cast in an iron form.

The table contains 11 compositions and their optical values by way of example:

TABLE

EXAMPLE	1	2	3	4	5	6	7	8	9	10	11
SiO_2	10.80	5.40	7.10	10.90	7.35	10.35	7.75	7.45	12.70	14.55	7.40
B_2O_3	6.35	3.00	4.40	6.55	4.35	5.80	5.85	4.25	6.90	7.10	4.20
La_2O_3	54.85	49.45	47.90	47.75	43.80	50.10	55.30	54.25	45.65	46.30	53.50
ZrO_2	8.50	5.75	5.35	5.80	6.20	9.60	8.40	3.65	7.60	7.05	7.50
Nb_2O_5	4.35	8.55	8.35	7.10	5.40	6,50	9.70	9.60		11.60	9.47
Ta_2O_5	13.50	9.45	12.55	8.35	7.65	10.50	11.00	10.90	16.35		10.75
PbO	1.00	11.95	1.75	2.45	2.25	4.70	1.30	3.60		0.75	3.55
TiO_2	0.65	6.45	12.60	0.80	0.75		0.70	6.30		0.40	3.65
				WO_3	WO_3	Zno			Gd_2O_3	Gd_2O_3	
				10.30	22.25	2.45			10.80	12.25	
nd	1.9111	2.0488	2.0373	1.9189	1.9712	1.9255	1.9594	2.0430	1.8630	1.8780	1.9940
vd	38.50	27.10	26.75	34.50	30.75	35.60	35.00	30.10	42.10	38.20	31.40
SiO_2/B_2O_3	1.70	1.8	1.61	1.66	1.69	1.78	1.32	1.75	1.84	2.05	1.76

What is claimed is:

1. CdO- and ThO-free, highly refractive optical glass which are stable to devitrification and have a refractive index nd of 1.85–2.05 and an Abbe index vd of 25–43, consisting essentially of the following composition (in percent by weight):

SiO_2	5–15
B_2O_3	2.5–8
$SiO_2 + B_2O_3$	7–23
SiO_2/B_2O_3	1.6–1.9
La_2O_3	43–56
Gd_2O_3	0–14
$La_2O_3 + Gd_2O_3$	43–60
ZrO_2	5–9
Nb_2O_5	0–15
Ta_2O_5	0–20
$Nb_2O_5 + Ta_2O_5$	11–22

2. Glass as claimed in claim 1, further containing 0.4–13 percent by weight of TiO_2.

3. Glass as claimed in claim 1, further containing 0.75–13 percent by weight of PbO.

4. Glass as claimed in claim 1, further comprising 10–23 percent by weight of WO_3.

5. Glass as claimed in claim 1, further containing 1–3 percent by weight of ZnO.

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